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FOWL CHOLERA.

By ARCHIBALD R. WARD.

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FOWL CHOLERA.

By ARCHIBALD R. WARD.

The importance of the poultry industry in California has occasioned a demand for the investigation of the problems of poultry management. In response, the Legislature of 1903 appropriated five thousand dollars ($5,000) to be expended by the Regents of the University of California for this purpose, in the manner indicated in the following quotations from the Act:

SECTION 1. There is hereby established in the County of Sonoma, at or near the City of Petaluma, a poultry experiment station, to be known as the "California Poultry Experiment Station."

SEC. 2. The purposes of said station shall be the study of the diseases of poultry to ascertain the causes of such diseases, and to recommend treatment for the prevention and cure of the same; to ascertain the relative value of poultry foods for the production of flesh, fat, eggs, and feathers; to recommend methods of sanitation, and to conduct investigations for the purpose of securing results conducive to the promotion of the poultry interests of the State. This Act shall be liberally construed to the end that the station hereby established may at all times contribute to the technical and general knowledge of the public upon the subject of poultry husbandry.

SEC. 3. The said station shall be under the supervision of the Director of the Agricultural Experiment Stations of the State of California, who shall, from time to time, cause to be issued bulletins of information regarding the care of poultry.

Poultrymen in the United States frequently report losses from fowl cholera, but nevertheless very few opportunities to make careful study of an outbreak have been afforded to those charged with the duty of publishing information on the prevention of poultry diseases. Salmon[1], about 1880, reported a disease in South Carolina, which he believed to be identical with the fowl cholera of Europe, described earlier by Perroncito[2], Pasteur[3], and others. The undeveloped condition of methods of bacteriological investigation at the time prevented that writer from furnishing conclusive evidence of the identity of the European and American diseases. Moore[4], about 1894, obtained sick and dead birds from three outbreaks of a disease popularly called fowl cholera, but found that the disease observed by him was not the fowl cholera of Europe. Some time afterward he published[5] a description of this new disease, giving it the name infectious leukæmia. Higgins[6] in Canada reported an outbreak of the true European fowl cholera. Friedberger and Fröhner[7] (Hayes translation) use the names fowl cholera and fowl typhoid interchangeably, in their description of the disease more commonly known by the first designation. Curtice[8] has very recently published a bulletin dealing with the disease described by Moore, but calls it fowl

typhoid. The essential facts concerning the symptoms and recognition of these two diseases have been brought together in chapters of a book written by Moore[9].

In America, opportunities for making an accurate diagnosis of fowl diseases, reputed to be "the cholera," have been rare. This may be charged principally to the familiar disinclination of poultrymen to admit the existence of disease among their stock. Neither of the American writers on fowl cholera, cited above, report field trials of repressive measures.

Fowl Cholera in California.—In October, 1903, a poultryman reported to the Agricultural Experiment Station that severe losses from "the cholera" were occurring upon his own and other ranches in Marin County. The presence of the disease was brought to his notice three weeks before by twelve dead hens being found under the roosts on one morning. On the second day as many more were found, after which, deaths practically ceased for a week, when losses again occurred at the rate of from six to ten a day. In the three weeks from the start the disease had spread to four adjoining colonies, and about one hundred fowls had died during the time.

The request of the poultryman for advice was met by an extended visit at the ranch to study the nature of the disease and to suggest repressive measures. The symptoms of the sick fowls, the internal alterations resulting from the disease, and a bacteriological examination led to the conclusion that the true fowl cholera had been encountered. The serious foothold already gained among five colonies, comprising nine hundred fowls, necessitated prompt action to prevent its spread to the remaining two thousand fowls.

The poultry ranch in question was stocked with about three thousand fowls distributed over several hundred acres of land in colonies containing about one hundred and seventy-five fowls. Each colony was supplied with roosting houses, a laying house, a grain-feeding hopper, feeding troughs, and drinking-water fountain. The several colonies were near enough together so that those hens venturing farthest abroad during the day would intermingle with those from other colonies—a fact of significance in relation to the spread of the disease. The writer has observed hens to go several colonies from home, attracted by the feed in the wagon from which the daily rations were distributed.

An experiment was performed to determine the length of time elapsing between exposure to infection and death. Ten cockerels were selected from one of the colonies that was free from disease, and, as subsequent events proved, so remained. All were placed in a crate, and were allowed to eat freely of the entrails and flesh of a fowl dead of the cholera. The dates of death are recorded in the following table:

TABLE I.

Deaths After Eating Infectious Material.

Fed viscera of dead fowls on October 11.

	Date of Death.
No. 1	October 12, early in morning.
No. 2	October 13, 5 P. M.
No. 3	October 17.
No. 4	October 13, early in morning.
No. 5	October 12, 1 P. M.
No. 6	October 15, during night.
No. 7	October 13, during night.
No. 8	October 16.
No. 9	October 14, 8 A. M.
No. 10	October 12, 1 P. M.

As each one died an examination of the internal organs was made, and conditions were found identical with cases that contracted the disease naturally. The experiment shows that the disease is very rapidly fatal, a large percentage dying within three days after exposure. The results demonstrate most emphatically the necessity for the immediate disposal of dead fowls to prevent the infection of other fowls by eating their carcasses.

Prevention must be the fundamental idea of all methods of dealing with an infectious disease like fowl cholera. In consequence, measures directed against it must be based upon a knowledge of the ways by which it is naturally spread from one individual to another. The fact that the blood at death teems with the bacteria of fowl cholera signifies that any part of the flesh or entrails is dangerous to other fowls when eaten. This fact was demonstrated in the experiment with the cockerels, all of which died within a week after eating entrails of dead fowls. The occurrence of extensive alterations in the walls of the intestine permits the mixture of blood with the contents of the intestine. Consequently the bacteria of the disease are present in the manure, thus rendering it a most serious factor in the spread of the disease. The probability of this material being mixed with the food by the feet is always to be considered.

Another way by which a sick fowl may spread disease is by means of the liquid that drips from the beak in some cases. As sick fowls are thirsty and frequently drink, there is opportunity of contaminating the drinking water. Since all sick fowls are a source of danger to others their immediate slaughter is imperatively necessary.

Measures designed to control the various sources of infection were put into operation as promptly as circumstances indicated the necessity for them. No information was available concerning the relative importance of the various possible sources of infection. Consequently the preventive measures were experimental in nature to a certain extent and were elaborated somewhat from time to time. Table II, on page 9, shows the date of inauguration of the various measures, with their apparent effect upon the death-rate.

The infectious nature of the disease indicated the necessity for thorough and frequent spraying of poultry houses with some substance capable of destroying the bacteria of the disease and of minimizing the number of parasites that might spread the infection. A mixture of crude carbolic and crude sulfuric acids was used for some time, but later the sulfuric acid was replaced by phenolene. It was deemed best to spray all of the poultry houses on the ranch daily, without reference to the distribution of the disease.

Mr. H. O. Woodworth, foreman of the California Poultry Experiment Station, personally took charge of the application of the disinfectant, and the enforcement of other sanitary measures. He kept a record of the death-rate, and from time to time changed the composition of the disinfectant. Notes on the sanitary control of the cholera, suggested by his experience, follow:

"A disinfecting solution recommended in publications of the Bureau "of Animal Industry was selected for spraying in the roosting and "laying houses to destroy the infectious material. Dr. D. E. Salmon "describes its preparation, in Farmers' Bulletin No. 24, U. S. Depart- "ment of Agriculture, as follows:

"'Crude carbolic acid, ½ gallon; crude sulfuric acid, ½ gallon. These "two substances should be mixed in tubs or glass vessels. The sulfuric "acid is very slowly added to the carbolic acid. During the mixing a "large amount of heat is developed. The disinfecting power is height- "ened if the amount of heat is kept down by placing the tub or "demijohn containing the carbolic acid in cold water, while the sulfuric "acid is being added. The resulting mixture is added to water in the "ratio of 1 to 20. One gallon of mixed acid will thus furnish twenty "gallons of a strong disinfecting solution, having a slightly milky "appearance.'

"A small bucket spray-pump was used to apply the disinfectant. "The spraying outfit, together with a barrel of the disinfectant, was "moved on a sled from one colony to another. The liquid was sprayed "upon the floor, side walls, and perches of the roosting houses and "upon the floor, and side walls up to the nest, of the egg houses. The "ground was sprayed for several feet around the houses. Especial "care was paid to the shady side where the chickens spent considerable "time during the day. The infected colonies were all sprayed daily "from the 9th to the 15th of October inclusive. All the other colonies "were sprayed daily except Sunday.

"On the 16th, it was decided to change the spraying solution, on "account of several objectionable features of the one in use. The "spray affected the eyes so that the man doing the work could not go "into the houses and do as thorough work as should be done. Further, "the mixture made the hands sore, ruined clothing, and destroyed the "rubber hose used on the spraying pump after a few days' use.

"Crude carbolic acid alone was then used in a strength of one gallon "to twenty gallons of water. The houses of the infected colonies were "sprayed with this mixture from the 16th to the 20th inclusive, the "houses of the other fowls being sprayed on the 17th and 19th only "during the same period. It was found very difficult to keep the mix- "ture sufficiently agitated to insure a uniform spray, so another change "was made on the 21st.

"The mixture next adopted consisted of one-half gallon each of "phenolene and crude carbolic acid to twenty gallons of water. This "proved satisfactory, except that it injured the hose somewhat.

"To spray the sixty houses and surroundings thoroughly once re- "quired forty gallons of disinfectant. To make this amount there were "used one gallon of sulfuric acid at 60 cents, and one gallon of crude "carbolic acid at 50 cents. Thus the expense for material was $1.10, "or slightly less than 2 cents a house per day. To do the same work "using crude carbolic acid alone, costs $1 a day. The last mixture "used, and which experience showed to be the best to handle, is the "cheapest. This mixture costs 50 cents for the gallon of crude carbolic "acid, and 20 cents for the gallon of phenolene. The daily expense per "house with the carbolic-phenolene mixture was thus a trifle over one "cent. The spraying was continued twenty-five days, and the expense "for all the materials for this time was $21.10. Had the carbolic- "phenolene mixture been used for the whole time the expense would "have been $17.50. The carbolic-sulfuric mixture would have cost "$27 for the same length of time. The labor required to spray sixty "houses each day consumed four hours' time for two men and a team."

The roosting houses were cleaned once a week, and the manure was placed in a part of the ranch where there would be no possibility for it to contribute to the spread of the disease.

When fowls are fed from open troughs, or when the feed is placed directly on the ground, there is a strong probability that the feed may become contaminated from the droppings of sick birds. The practice of feeding from open troughs was discontinued. Troughs were made so as to permit the fowls to reach the head in, but to prevent the feet from coming in contact with the feed.

On account of the danger to the fowls from the contaminated ground about the houses, the five infected colonies were moved on October 14th to another part of the ranch.

The practice of slaughtering all hens sick of the cholera was inaugurated promptly; but as the disease was noticeable for only a short time before death, many had opportunity to spread infection before detection. On October 17th (see Table II) it was decided to kill every hen that showed the slightest symptoms of any sort of disease. It was found very desirable to visit the roosting houses at daybreak, for at that time the sick ones are almost certain to be found lingering in the houses.

The early visit also permitted the collection of the dead before the living could become infected by eating portions of them. For the purpose of restricting the possibility of fowls becoming infected from the droppings in the houses before the daily spraying, it was made the practice to drive out the hens early in the morning and to shut the doors until after the spraying.

The dead were burned or buried deeply, as convenient. Scrupulous care was exercised to dispose of the dead before the living fowls could molest them.

A number of fowls among those frequenting the vicinity of the house and barns were lost from the cholera. Two turkeys also died within a few hours after they were first noticed to be sick. These birds had abundant opportunity to catch the disease from sick and dead ones brought from the infected colonies. The few fowls about the house were caught and placed with one of the infected colonies.

On October 20th it was deemed necessary to place in the drinking water some substance known to be fatal to the fowl cholera bacteria and thus insure drinking water free from danger of communicating the disease. It was decided to use corrosive sublimate in the drinking water of the infected colonies, as suggested by Ritzer[10]. That substance is a violent poison to most creatures, and there was some fear that it would have an undesirable effect upon the egg yield, if no worse would result. Stoneware drinking fountains were used, because the corrosive sublimate would have combined chemically with the metal drinking fountains in common use. For convenience in making up the solution of the desired strength, corrosive sublimate and ammonium chlorid in the form of compressed antiseptic tablets, prepared by John Wyeth & Bro., were used. The tablets contain such an amount of corrosive sublimate that one tablet in a pint of water makes a 1 to 1000 solution, making the preparation of a solution of any weaker strength a simple matter.

Mr. H. O. Woodworth has written the following paragraph, giving information regarding the strength of corrosive sublimate solution used:

"Corrosive sublimate in the strength of 1 part to 1000 parts of water "(16 tablets to a 2-gallon drinking fountain) was used on October 21st, "but it was observed that the chickens did not drink freely of the "mixture. The next day 13 tablets to the 2-gallon fountain were used, "which mixture the fowls drank more freely. Largely from fear of "evil consequences of the use of a strong solution, it was decided to "further dilute the corrosive sublimate, using 8 tablets to 2 gallons of "water, or a dilution of 1 to 2000 parts of water. This strength of solu"tion was supplied the infected colonies on October 25th and 26th. "The same was used from October 30th to November 5th inclusive. "No injurious effects were noted. A decrease in the egg yield may pos"sibly have been due to its use. A word of caution should be uttered "regarding the danger of too free use of corrosive sublimate, on account

"of its poisonous properties. The cost of purifying the water with cor-
"rosive sublimate was $7.59 for the whole period."

Corrosive sublimate was used in the drinking water solely for the purpose of killing any of the bacteria of fowl cholera that might gain access to it, thereby eliminating one of the possible sources of infection. It was not used as a medicinal remedy.

The control of the drinking water of the fowls is a comparatively simple matter in the dry season. An outbreak in wet weather would present much more serious difficulties, for every puddle of water on the ground is more than liable to be contaminated from the droppings. Under such conditions fowls would catch the disease much more readily.

The writer made no suggestions regarding the character of the feed to be supplied, as that matter was regarded as having no bearing upon the problem.

TABLE II.

Effect of Preventive Measures upon Death-rate.

		Deaths from Cholera, including those killed.
Sept. 17.	Disease first appeared in one colony.	
Oct. 7.	Now involves five colonies. Total deaths to date, about	100
8.		48
9.	Began spraying daily and killing sick	22
10.		34
11.		26
12.		18
13.		10
14.	Moved infected colonies	10
15.	Sanitary feeding troughs first used	10
16.		?
17.	Began slaughter of all fowls suspected of being sick	12*
18.		10*
19.		6*
20.	Corrosive sublimate first used in drinking water	7
21.		2
22.		7
23.		4
24.		4
25.		3
26.		2
27.		2
28.		1
29.		4
30.		1
31.		3
Nov. 1.		0
2.		0
3.		3
4.		0
5.	Stopped sublimate in water. Stopped spraying.	
	Total	349
	Since beginning preventive measures	201

*The numbers here reported refer to the fowls that died of the cholera. On the same days 55 fowls were killed by the owner because noticeably sick from some disease not determined. As roup was prevalent among the fowls at the time, there is good reason to believe that but a small percentage of those killed had the cholera.

A study of the daily death-rate in its relation to sanitary measures brings out the fact of the efficiency of merely destroying the sick fowls and then disinfecting thoroughly. These measures alone were enforced until the daily death-rate dropped to 10.

It would be unsafe to draw conclusions concerning the actual benefit of the use of corrosive sublimate, for during its use extreme vigilance was exercised to weed out sick fowls. Moreover, its use was commenced about the time when the beneficial effects of disinfection might be expected to become evident.

Work on the ranch under the supervision of the Experiment Station was discontinued on November 5th. After this date the disinfection herein described was not carried out. Each time the houses were cleaned the floors were sprinkled with lime. In December about twenty-five fowls were lost. Occasional deaths after this did not excite alarm until about April 1st, when about fifty fowls were lost in a few days among the colonies originally infected six months before. This experience illustrates the danger of relaxing vigilance in dealing with fowl cholera. Any deaths from cholera must be considered alarming, for without repressive measures extensive losses are liable to occur at any time. A mere lowering of the death-rate furnishes no grounds for a feeling of security.

At the present writing (April 4) the owner has decided to dispose of the remaining fowls in the infected colonies, which will eliminate the danger of the spread of the disease.

Spread of the Disease.—The spread of the disease across the country has been the subject of some speculation. The evidence indicates that the movement of fowls is one of the important causes of the introduction of the cholera into flocks where it was hitherto unknown. The ranch upon which the Station work was done appears to have become infected from an adjoining one where the disease existed, for the trouble first appeared in a colony nearest to the second ranch and where fowls could readily intermingle. A third ranch, adjacent to both of these, had been stocked with fowls purchased in a locality several miles distant, where cholera was known to have been seriously prevalent.

The cholera and other infectious diseases may exist in a fowl in a sort of inactive, chronic condition, and there is no doubt concerning the agency of such a case in spreading the disease. Thus, fowls not suspected of being diseased may have the disease smouldering among them. The fact that occasionally a single fowl dies of cholera means that a severe loss may occur at any time.

The possible importance of pigeons and wild birds as a means of spreading contagion is worthy of consideration. The fact that pigeons contract the disease and die has been demonstrated in an experiment

reported on page 19. Earlier writers have reported that many different kinds of birds are susceptible to fowl cholera.

The practice of throwing dead fowls by the roadside is an important means of distributing the cholera. When the disease breaks out it is not uncommon for poultrymen to crate their fowls and take them to market. Not infrequently fowls die during the trip to the shipping point and are thrown out by the driver. Should this be done in front of a poultry ranch it is very liable to result in the further spread of the disease, for fowls eagerly eat the dead ones. The presence of fowls dead of the cholera along a roadside is a matter of common observation; two instances of the infection of poultry ranches from this source have been reported, and in both instances outbreaks involving serious losses have resulted. This practice is prohibited by legislation in Sonoma County, but it is practically impossible to secure evidence to convict the offenders.

An example of the relation of a stream of water to the spread of fowl cholera has come to notice. A poultryman whose fowls had been free from the disease noticed one evening that several dead fowls had drifted ashore from the creek running through his ranch. The next morning the carcasses were found stripped to the bone, partly eaten by skunks during the night, and later by chickens from a nearby colony. Fifty-eight fowls in the same colony died during a day and a night. The entire colony was disposed of promptly, but not until one hundred had died. No further trouble was experienced. At least two ranches up stream were known to be infected with the disease, which suggests an explanation for the presence of dead fowls in the stream.

The spread of the cholera on a ranch is often greatly hastened by the poultryman, through failure to recognize the necessity for isolating affected fowls. An interesting case has come to notice. The fowls in a colony along the roadside became infected from dead fowls that had been thrown into the ditch. A number of dead fowls from that colony were brought to the house, where they were allowed to remain exposed long enough to start the disease among the two hundred fowls frequenting the vicinity of the house. With the hope of stopping the disease by moving these fowls, they were placed in a colony by themselves. The isolation from other fowls was not complete, and the infection spread. Disinfection was practiced intermittently and the dead were not gathered up promptly. Six months after the introduction of the disease, losses continued. The owner estimated that at least one thousand fowls had died during the period mentioned.

The experience of another poultryman in the neighborhood furnishes information worthy of record. After having his stock of fowls depleted by the ravages of the disease, he determined to replace the losses by purchase of healthy fowls. As the disease existed in practically every

colony at the time, the problem of introducing fresh stock was a serious one. The owner decided to make the attempt in a field containing three colonies in which eight hundred and seventy fowls had been lost out of thirteen hundred and fifty originally there. The survivors were removed to other colonies on the ranch. The houses of the three colonies were cleaned, whitewashed, and the floors sprayed with phenolene. Each of the three groups of houses was moved about two hundred yards from its former location and was left untenanted for two weeks. Nine hundred and fifty fowls were then distributed among the houses and no cholera appeared among them. That the field in question was quite isolated from other infected colonies is believed to be another factor that contributed to the happy result.

Symptoms.—The yellow color of the droppings is the first noticeable symptom. The yellow material consists of the kidney excretion (urates), which is apt to soil the feathers covering the abdomen, a condition that should be looked for in suspected cases. Diarrhœa appears later. The character of the dung varies considerably in color and consistency. Sometimes it is a pasty, greenish mass, or a brownish red mucus, or a viscous, transparent fluid. The yellow color of the urates is the most noticeable feature.

The sick fowl gives evidence of its condition by an unnatural attitude of the feathers, and by a disinclination to move about as usual. None were observed to eat during the later stages of sickness. Thirst is frequently present, for fowls were observed to drink copiously in the advanced stages of the disease. A mucous discharge from the mouth was occasionally noticed. Toward the end, drowsiness is very marked. The temperature in advanced stages of naturally infected cases varies from 109° to 112° F. (42.8° to 44.4° C.). The temperatures of several fowls inoculated with cultures are tabulated below. Nos. 1, 2, and 3 were inoculated subcutaneously ten hours previous to taking the first temperature. No. 4 was inoculated seventeen hours before the first temperature was taken. In each case death occurred during the night following the last recorded temperature, except in the case of No. 3, which died twenty-four hours later. Approximately, 0.01 c.c. of a 24-hour bouillon culture was injected in each case.

TABLE III.

Temperatures of Inoculation Cases of Fowl Cholera.

	No. 1.	No. 2.	No. 3.	No. 4.
March 18, 9 A. M.	41.1° C.	41.3° C.	41.9° C.	43.4° C.
10 A. M.	41.7	41.3	41.7	42.6
11 A. M.	41.7	41.3	41.6	43.2
12 M.	42.3	41.3	41.6	44.1
1 P. M.	43.0	41.1	41.8	44.0

TABLE III—Continued.

Temperature of Inoculation Cases of Fowl Cholera.

	No. 1.	No. 2.	No. 3.	No. 4.
March 18, 2 P. M.	42.7° C.	41.0° C.	42.0° C.	43.8° C.
3 P. M.	42.4	40.4	42.0	43.6
4 P. M.	42.2	40.6	41.8	
5 P. M.	41.9	40.6	42.0	
6 P. M.	42.4	41.4	42.0	
7 P. M.	42.2	41.2	41.0	
8 P. M.	43.1	41.6	41.2	
March 19, 11 A. M.	41.4		43.0	
12 A. M.	40.8		42.7	
1 P. M.	40.4		42.6	
2 P. M.	40.7		42.4	
4 P. M.	40.0		42.8	
March 20, 10 A. M.			42.8	
12 M.			42.2	

The temperatures observed in cases 1, 2, and 3 rarely were high enough to be regarded as febrile. Numerous observations on healthy fowls show that the normal temperature of healthy fowls most often lies between 41.7° C. and 42.2° C. A considerable number of apparently healthy fowls exhibited temperatures as high as 42.8° C. No. 4 exhibited a distinctly febrile condition, and corresponded better than the others with the temperatures of naturally infected fowls observed during the study of the disease in the field.

In the majority of cases in which the time of exposure to the disease was known, death occurred within three days. The tabulated results of the inoculation of fowls by the ingestion of infectious material, page 5, show that the incubation period may be as short as eighteen hours in cases infected by natural means. Sickness was seldom noticed more than twenty-four hours previous to death. All the cases that came under the writer's observation were acute. No recoveries were noted. The fact that more deaths occur on the roosts at night than in the day time was noticeable.

Fowl cholera can not be certainly recognized by the poultryman without the aid of a bacteriological examination, but at the present time this fact is of no significance. The methods of combating the cholera are practically not different from those that should be applied in the other plagues of poultry closely resembling fowl cholera. The occurrence of numerous sudden deaths among fowls is indicative of an infectious disease, and should be the signal for the inauguration of sanitary measures.

Changes observed in the various organs, upon post-mortem examination, are comparatively slight; a circumstance not surprising, in view of the brief period of sickness. A technical description of the alterations, unprofitable to the general reader, is appended.

OBSERVATIONS UPON THE PATHOLOGY OF FOWL CHOLERA.

At death, or some hours previous, the comb frequently takes on a dark purple color, but this does not always occur. Very often the comb is pale and bloodless. The skin of the breast and abdomen is frequently reddened.

In post-mortem examinations a congestion of the blood vessels of the liver, kidney, mesentery, or intestines is noticeable to some degree in all cases. Punctiform hemorrhages are found upon the heart with almost absolute uniformity. The liver is very frequently marked with punctiform whitish areas of necrosis. Stained sections show these necrotic foci throughout the substance of the liver, and besides reveal a congestion of the blood vessels of that organ. The next most striking lesions occur in the first and second duodenal flexures. The mucosa is deeply reddened and studded with hemorrhages varying in size, but seldom exceeding one millimeter in diameter. These involve the intestinal coats to an extent that makes them distinctly visible on the peritoneal surface. The contents of the duodenum consist of a pasty mass, more or less thickly intermingled with blood clots. The intestinal contents sometimes consist of a cream-colored pasty mass, or may be brownish red or even green in color. Lesions are very rarely observed in other portions of the intestines. The ureters are noticeable in practically all cases by reason of the yellow-colored urates that they contain. The nasal cavity, pharynx and oral cavity frequently contain a viscous mucous fluid, probably regurgitated from the crop.

The field notes on twenty-one post-mortem examinations reveal reference to the hemorrhages upon the heart in twenty-one cases; punctiform necroses of liver, fifteen cases; hemorrhages in duodenum, seven cases; and discoloration of skin in six cases. The presence of a gelatinous exudate within the pericardium was noted twice. A fibrinous exudate in the pericardium occurred the same number of times. Hemorrhages in the peritoneum other than those visible through the mucosa of the duodenum occurred but twice. In one case hemorrhages were abundantly scattered throughout the muscles of the trunk and legs.

Fowls inoculated subcutem with cultures exhibit on post-mortem examination the punctiform hemorrhages on the heart and the hemorrhages in the mucosa of the duodenum exactly as in cases infected naturally.

Two turkeys fell victims to the disease. The symptoms and lesions did not differ markedly from those in hens. Notes on the post-mortem examinations of these cases are appended:

October 14. Hen turkey observed to be sick. Temperature about two hours before death, 112.6° F. (44.8° C.); no reddening of skin. Heart muscle contains some punctiform hemorrhages. The cæca, mesentery, and intestine are covered with a yellowish

fibrinous exudate. The intestines contain dark, pasty feces. The vessels on the peritoneal surface of the gizzard are congested. The lungs, proventriculus, intestines, kidneys, and spleen are not visibly altered.

October 14. Gobbler, found soon after death. There is no discoloration of skin. Lungs are congested and dark red in color. The dorsal aspect of the lungs is covered with a gelatinous exudate, which liquefies upon exposure. The œsophagus and crop are normal. The proventriculus contains a greenish, transparent, gelatinous substance mixed with blood clots. The gizzard contains a few blood clots. The mucosa of the intestines, from the gizzard as far as the cæca, are congested. The duodenum contains yellowish, pasty mucus, with occasional clots of blood. The cæca are distended with material of normal appearance. Vessels on the peritoneal surface of the duodenum and of mesentery are congested.

Blood Counts.—In comparing the lesions of infectious leukæmia and of fowl cholera, Moore[8] has pointed out the desirability of a study of the blood in the latter disease. Consequently the opportunity was seized to make the blood counts tabulated below:

TABLE IV.

Blood Counts of Fowls Infected by Ingestion and Infected Naturally.*

Fowl.	White.	Red.	Remarks.	Temperature
No. 3	23,000	2,290,000	3 days after exposure to infection	44.8° C.
No. 3	20,000	2,800,000	4 " " " " "	43.7° C.
No. 6	37,000	3,930,000	3 " " " " "	43.3° C.
No. 8	87,000	4,490,000	3 " " " " "	42.8° C.
No. 8	101,000	2,960,000	4 " " " " "	42.2° C.
A	58,000	1,710,000	Naturally infected	42.8° C.
B	45,000	1,925,000	" "	-------

TABLE V.

Blood Counts of Apparently Healthy Fowls.

Fowl.	White.	Red.
No. 11	24,000	2,980,000
No. 12	26,300	2,987,000
No. 14	36,000	3,115,000
No. 15	52,000	3,980,000
No. 16	61,000	3,920,000
No. 17	30,000	2,380,000
No. 18	24,000	3,620,000

In the case of No. 8, a marked diminution of the red corpuscles and increase of the white corpuscles are noticeable. A comparison of the counts of fowls A and B with the normal counts would lead to the conclusion that a decrease of red corpuscles had occurred in cases of natural infection.

* Details of the method of infecting these fowls are given on page 4.

TABLE VI.

Changes in the Blood Counts of Fowls Inoculated with Cultures of the Fowl Cholera Organism.

Fowl.	White.	Red.	Remarks.	Temperature.
No. 11	24,000	2,980,000	Normal. Injected .5 c.c. 24-hr. cult. subcutaneous	42.3° C.
No. 11	19,000	3,380,000	23 hours after inoculation. Died 2 hours later	43.3° C.
No. 12	26,300	2,987,000	Normal. Injected .5 c.c. 24-hr. cult. subcutaneous	42.3° C.
No. 12	27,000	3,500,000	24 hours after inoculation. Died next day	42.3° C.
No. 13	129,000	3,300,000	Before inoculation. Injected .015 c.c.*	42.3° C.
No. 13	142,000	3,310,000	24 hours after inoculation	42.0° C.
No. 13	257,000	3,046,000	Died following day. Post-mortem showed tuberculosis and cholera	42.4° C.
No. 16	61,000	3,920,000	Normal. Injected .01 c.c.* subcutaneous	-------
No. 16	15,000	1,880,000	36 hours after inoculation. Died night after	-------
No. 17	30,000	2,380,000	Normal. Injected .01 c.c.* subcutaneous	-------
No. 17	22,750	1,590,000	30 hours after inoculation	-------
No. 17	14,500	1,700,000	48 hours after inoculation	-------

The figures for Nos. 11 and 12 reveal no marked change in the relative number of corpuscles during the short course run by the disease in these cases. No. 13 shows a marked leucocytosis in avian tuberculosis, increased by infection with cholera without disturbance of the number of red corpuscles. No other fowl in the list showed lesions of tuberculosis or other disease upon post-mortem examination. Nos. 16 and 17 show a distinct decrease of both classes of corpuscles. Fowls 8, A, B, 16, and 17 furnish evidence that a marked diminution of red corpuscles may occur. This fact accounts for the pale appearance of the blood commented upon by some observers.

In all cases Toisson's fluid was used for diluting in the pipette. During the counting there were noted bodies resembling the red corpuscles, but somewhat smaller and, unlike them, were stained blue. They occurred singly sometimes, but more often in clusters, which fact occasioned some embarrassment during the leucocyte counts. They occur in both normal and pathological blood. In mounted specimens of fresh blood they occur in clusters and show a refractive nucleus with sharply defined border, surrounded by protoplasm with a poorly defined border. The protoplasm is deficient in amount as compared with the red corpuscles, and among the clusters apparently free nuclei are observed. With the Wright-Jenner stain the nuclei behave in general like those of leucocytes, but appear larger, while the protoplasm takes on a pale blue color. The cells quite closely resemble those of the red corpuscles, except that some are more narrow and others smaller.

Moore[5] has mentioned the fact of red corpuscles staining in Toisson's fluid. Under the designation of red corpuscles, he has pictured cells identical in morphology with those just described. The present writer has regarded the bodies in question as atypical red corpuscles, and has ignored them in the blood counts. In one specimen of pathological blood in which it was fancied that they were more numerous

* Culture diluted and figures consequently approximate.

than in normal blood, they were counted with great difficulty. In this instance 400 squares were gone over, and the conclusion reached that the sample contained 54,000 per cubic millimeter.

Phagocytosis has not been observed in mounted specimens of fresh blood.

Culture media implanted from the liver, spleen, kidneys, and heart blood of fowls and turkeys yielded cultures of a bacterium possessing the characters of the *Bacterium septicæmiæ hemorrhagicæ* group. A description of the organism follows:

Morphology.—The individual cells are short, non-motile rods, with rounded ends. They usually occur singly, but a few are seen in pairs. Spherical forms are numerous in actively growing cultures. The size varies from .4 to .6 μ broad and from 1 to 2 μ long. A bipolar arrangement of the protoplasm is demonstrated when carbol fuchsin and alkaline methylene blue stains are used. The bipolar staining is noticeable frequently in smear preparations from tissues. The presence of a capsule is suggested by an unstained area surrounding each organism when a background of stain is deposited upon the cover glass. The same appearance is noticeable in smear preparations from tissues. The organism retains the stain but faintly when treated after Gram's method.

Biologic Characters.—The organism is aërobic and facultative anaërobic. It grows readily at 37.5° C., and with much less rapidity at room temperature.

Agar.—The colonies on one per cent agar, after forty-eight hours incubation at 37.5° C., appear as round, smooth, thin, shiny disks, with entire* border and measuring about 2 mm. in diameter. Under a two-thirds objective they appear coarsely granular and show concentric circular markings. They appear smoky brown in color by directly transmitted light, and gray by reflected light. Colonies beneath the surface are usually lenticular in shape, and the granular appearance is more marked under a two-thirds objective than in the surface colonies. After twenty-four hours the growth on the agar slant culture is flat, smooth, shining, translucent, grayish white by reflected light, and smoky brown by transmitted light, with undulate border. The condensation water becomes decidedly turbid. After the first week of growth the liquid clears somewhat with the deposition of a viscous sediment. No pellicle has been observed on the condensation water.

Glycerine Agar.—Growth upon this medium presents no features distinguishable from that upon agar slant.

Gelatin.—Surface colonies, after about two weeks' growth at room temperature, are round, vitreous masses, with entire border and smooth shiny surface. A large proportion of the colonies are raised, forming a conical mass not exceeding 1 mm. in diameter. Such colonies appear

* The descriptive terms suggested by Chester[11] and by Kendall[12] are used.

highly refractive by directly transmitted light. Under a two-thirds objective the colonies have a finely granular appearance and show concentric circular markings. Sub-surface colonies are lenticular in shape and granular.

After three days' growth under similar conditions the growth in gelatin stab cultures is noticeable as a mass of closely aggregated colonies near the surface. After about two weeks the surface growth appears as a round, thin gray mass, with contoured surface and undulate border. At the same time the growth along the whole length of the path of the inoculating needle appears as a mass of closely aggregated distinct colonies.

Potato.—Implantations on this medium have not resulted in visible growth.

Alkaline Bouillon.—After forty-eight hours at 37.5° C. the fluid becomes slightly clouded and does not clear up on standing, even after four months. In cultures two or three days old no sediment is deposited, but in older cultures a viscous sediment accumulates. The reaction is alkaline to litmus and markedly so in old cultures. No pellicle is formed, but occasionally a circular bluish band of growth adheres to the tube at the level of the surface of the fluid.

Sugar-free Bouillon.—Growth is similar to that in alkaline bouillon.

Acid Bouillon.—The growth is similar in appearance to that in alkaline, except that the turbidity is less marked and no accumulations have been noticed at either surface or bottom of liquid. Reaction becomes alkaline in old cultures.

Milk.—No change occurs in this medium during the length of time that it is ordinarily kept under observation.

Fermentation Tubes.—(1) One per cent glucose bouillon: The liquid throughout the tube becomes uniformly slightly clouded in twenty-four hours at 37.5° C., and remains so. The reaction becomes acid in two days. No gas is formed. A slight amount of viscous sediment collects.

(2) One per cent lactose bouillon: The character of growth is similar to that in glucose. The reaction remains alkaline.

(3) One per cent saccharose bouillon: The growth is similar to that of the two preceding. The reaction becomes acid in two days, but eventually becomes alkaline in cultures several weeks old.

Dog Blood Serum.—After twenty-four hours at 37.5° C. the path of the needle is occupied by a smooth, shiny, raised growth of a color determined by that of the serum. The condensation water is markedly turbid. Six days later the growth, as well as the surface of a pellicle on the condensation water, has a coppery lustre.

Loffler's Blood Serum.—After twenty-four hours' growth at 37.5° C. the path of the needle is marked by a white, raised growth, with shiny, contoured or smooth surface and undulate border. The condensation liquid becomes decidedly turbid. After several days the surface of the

growth becomes dull. The liquid is then observed to contain a viscous sediment and to have patches of pellicle floating upon the surface.

Indol.—A positive reaction is obtained in sugar-free bouillon cultures.

Thermal Death-point.—This organism was, in two instances, destroyed in freshly planted tubes of bouillon standing in water at 57° C. for ten minutes. Exposure at 56° C. for the same length of time failed to kill the organism in one instance, and was fatal in another case.

Disinfectants.—Duplicate tests show that a drop of a 24-hour bouillon culture dried upon a cover glass is sterilized by exposure to direct sunlight for an hour. A similar experiment in which the organisms were exposed to diffused light in a dark corner indoors indicates that the organisms die in about four days under indoor conditions. 0.25 c.c. of a 24-hour bouillon culture was added to 10 c.c. of a 1:2000 solution of Wyeth's sublimate tablets. A culture implanted after one minute showed growth after incubation, but those made at three, five, and ten minutes were sterile.

Animal Inoculation.—Subcutaneous or intravenous injection of fowls with 1 c.c. of a 24-hour bouillon culture resulted in death in about fifteen hours. Doses as small as 0.05 c.c. killed in about three days. A young rabbit inoculated with 0.5 c.c. in an ear vein was found dead fourteen hours later. A guinea pig inoculated with 1 c.c. subcutem was found dead in fourteen hours. Another receiving 0.5 c.c. subcutem survived thirty-six hours. A pigeon swallowing 1 c.c. died in twenty-one hours, and another receiving 0.12 c.c. subcutem was found dead fourteen hours later.

SUMMARY.

Fowl cholera has been identified in California. The results of observation and experiments lead to the conclusion that the disease is introduced into the body through food and probably also water infected with the bacteria, causing the disease. Fowls eat their dead at every opportunity, which practice must be strictly guarded against during an outbreak. Contamination from the infectious droppings is prevented by disinfecting the roosting houses daily and by feeding from troughs designed to prevent fowls from walking in the feed. The same end is favored by moving infected colonies to fresh ground. Possible infection through the drinking water is prevented by placing a weak solution of corrosive sublimate in the drinking-water fountains. The prompt slaughter and thorough disposal of all sick hens during an outbreak contribute toward preventing the spread of the disease. The evidence goes to show that fowl cholera is a comparatively easy disease to control; but disinfection must be continued after the death-rate becomes insignificant.

The dissemination of the disease in some cases is undoubtedly due to

careless disposal of the dead. The movement of sick fowls is of importance in the same connection.

Observations show that it is possible to take new stock on land where the cholera has existed two weeks before, provided the buildings be moved and disinfected. This is confirmed by experiments in the laboratory, which show that sunlight and disinfectants rapidly destroy the bacteria.

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Mr. L. B. Chandler made the blood counts of fowls 11 to 15 inclusive.

Mr. A. R. Keith has assisted in preparing the description of the organism.

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